

The Composition of *Portunus pelagicus* on the Fishing Ground Area of Danasari Waters, Pemalang Regency

Sri Redjeki*, Ria Azizah, Hadi Endrawati

¹Marine Science Department, Faculty of Fisheries and Marine Science, Universitas Diponegoro
Jl. Prof. Jacub Rais, Tembalang, Semarang, Jawa Tengah 50275 Indonesia
Email: sriedjekikelautan@gmail.com

Abstract

Blue swimming crab (*Portunus pelagicus*) is one of Indonesia's most economically valuable marine products. The crabs productivity was generally still dependent on the population in the wild. Danasari Village is one of the main crab producers in Pemalang Regency. The daily fishing crab activities by fisherman directly impact decreasing natural crabs resources. This study determined the crab's composition in the fishing ground where, which the Danasari crab fisherman usually spotted research obtained information of the composition of female and male crabs, carapace width distribution, growth characterized, and the egg-berried female number. This study was conducted on May to July 2022. The result in this research was a male crabs were dominated than females. The carapace width was generally amount 92-112 mm, while the growth characteristic of blue swimming crabs was negative allometric. The female crab gonad maturity was dominated by 2nd level gonad maturity, while the egg-berried female crabs were found 21 crabs totaled from 14 spot fishing grounds. Based on the carapace width distribution, there are a lot of blue swimming crab with undersized in shallow-depth fishing sites, while the crab size mostly above 100 mm already found at each spot in this research. The highest egg-berried female percentage was found at spot 7th and 13rd, where the female crabs at 7th spot were bigger carapace than at 13rd spot areas. These results indicated that crab resources in Danasari Waters and surrounding areas were potentially overfished, proven with undersized berried-female crabs. The management efforts will conduct an environmentally friendly fishing gear, regarding the ministry's policy to keep crab resources sustainable. In addition, scheduling rules for fishing activities can also be tested to be applied.

Keywords: Carapace width, Sex ratio, Egg-berried female.

INTRODUCTION

Portunus pelagicus is a marine species with a high economic value about Rp.70.000/kg (Philis, *et al.*, 2022), but the production still depends on natural resources. Kumar *et al.* (2003) stated that the survival of blue swimming crab is very complex, and the life cycle differs in several phases. Adult crabs will spawn and release their eggs in the open sea with a substrate of sand and mud (Prihatingsih and Wagijo, 2009). Crab eggs hatch, and grow into larvae and young crabs in the coastal area with mangrove ecosystems (La Sara *et al.*, 2016).

Danasari was one of the producing crab's areas on the Java island. Blue swimming crab fishermen in Danasari Village carry out daily fishing activities, commonly known as a one-day trip. Blue swimming crab fishermen in Central Java generally go to fishing locations early in the morning and land their fishing traps in the afternoon and evening (Sari *et al.*, 2016). High fishing intensity can hurt the sustainability of crab resources. Ernawati *et al.* (2015) stated that several indications of blue crab resources already pressured due to fishing activity and can be seen from the size of the smaller crabs, the fishing area that is further away, and young female crabs under 100 mm in size that have mature gonads and even lay eggs.

The pressure on blue swimming crab resources must be resolved, considering the dependence on natural stocks in the wild. Kohinoor *et al.* (2019) showed that the survival rate for crab hatcheries was still shallow, with a proportion of only 40.10%. The efforts to manage fishing activities are an alternative that is usually applied by the local government, such as regulations on minimum carapace width, prohibition on catching female swimming crabs, and recommendations for using environmentally friendly fishing gear (Ernawati *et al.*, 2015). However, in reality, many forms of violations of the abovementioned regulations are limited for economic reasons by most fishermen in Central Java (Huda *et al.*, 2021). Information regarding the composition of blue swimming crabs at the fishing location can be a parameter to increase fishermen's awareness and give the information to some fishermen to decrease the catching activity. The study aimed to determine the composition of the crabs caught in the fishing area, including the composition of the female and male crabs, the composition of the crabs, and the distribution of the female swimming crabs laying eggs.

MATERIALS AND METHODS

The research was conducted in Danasari Village, Pemalang Regency, and carried out from May to July 2022. Purposive sampling methods are used for the data collection of crab catches by following the fishermen of Danasari Village in crab catching activities. The research map area is obtained in 14 points presented in Figure 1.

The data of crab catches observed a carapace width, body weight, sex, and female gonadal maturity by observing the morphological abdomen with 3 categories shown in Table 1 (Kunsook *et al.*, 2014), and oceanographic parameters of the waters at the fishing location. The equipment in this research used a digital pair of scales to weigh the crabs, a ruler to measure carapace width, a GPS to determine the coordinates of the fishing location, a mercury thermometer to measure water temperature, an ATC hand-refractometer to measure water salinity, a digital pH meter to measure water pH, and a Hi-9142 DO-meter to measure oxygen levels and dissolved at the fishing location. The data obtained were then analyzed to obtain results which included the sex ratio of female and male crabs, composition of the size of the carapace width, growth characteristics of the crab using regression analysis (King, 1995), maturity level of the gonads of the female crab, as well as the composition and distribution of the egg berried female (EBF). The observed crabs in this study are presented in Figure 2.

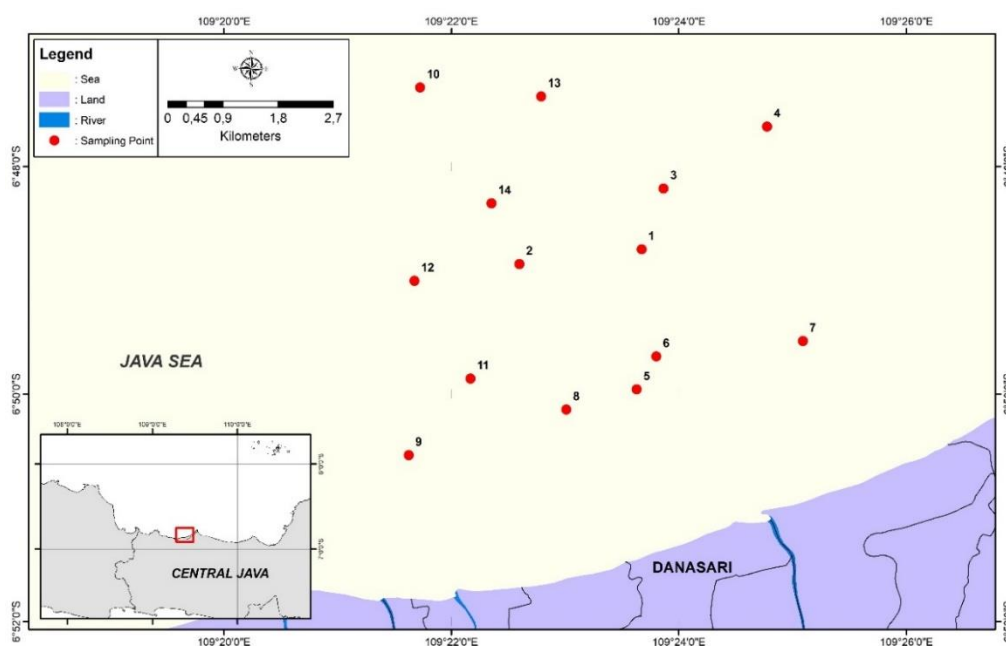





Figure 1. Map of the Catching Area by Fishermen of Danasari Village, Pemalang

Table 1. Female Crab Gonadal Maturity Level (GML) Category (Kunsook et al., 2014)

GML	Abdomen Morphology	Description
1 (Immature)		The abdomen is white and transparent and almost similar in shape to the male abdomen
2 (Matured)		The size of the abdomen is wide, dark in color (external appearance of the abdomen), and already contains gonads with a yellow to orange color.
3 (Ovigerous)		The eggs are located outside the abdomen, and the eggs are yellow-orange to gray-black in color. Already known as Egg Berried Female (EBF).

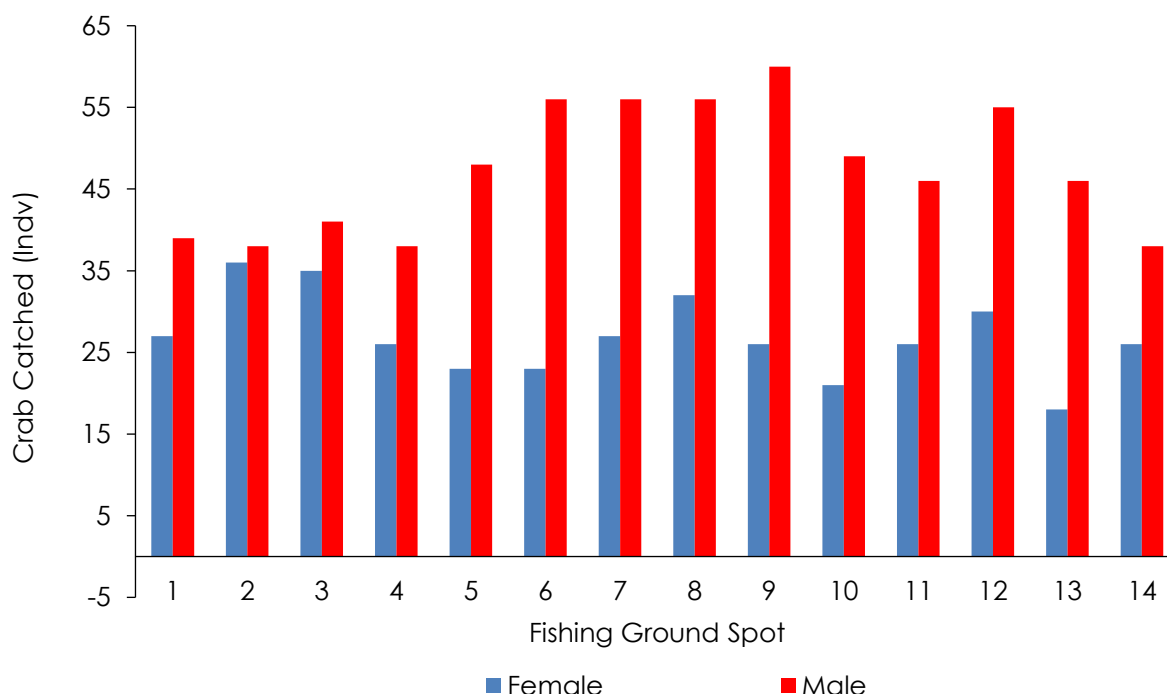


Figure 2. Observed Crabs at 14 spot fishing ground in Danasari waters

Result and Discussion

The observation of oceanographic parameters at the fishing location includes water temperature, salinity, pH and dissolved oxygen. The results of measuring oceanographic parameters of the waters are presented in Figure 3.

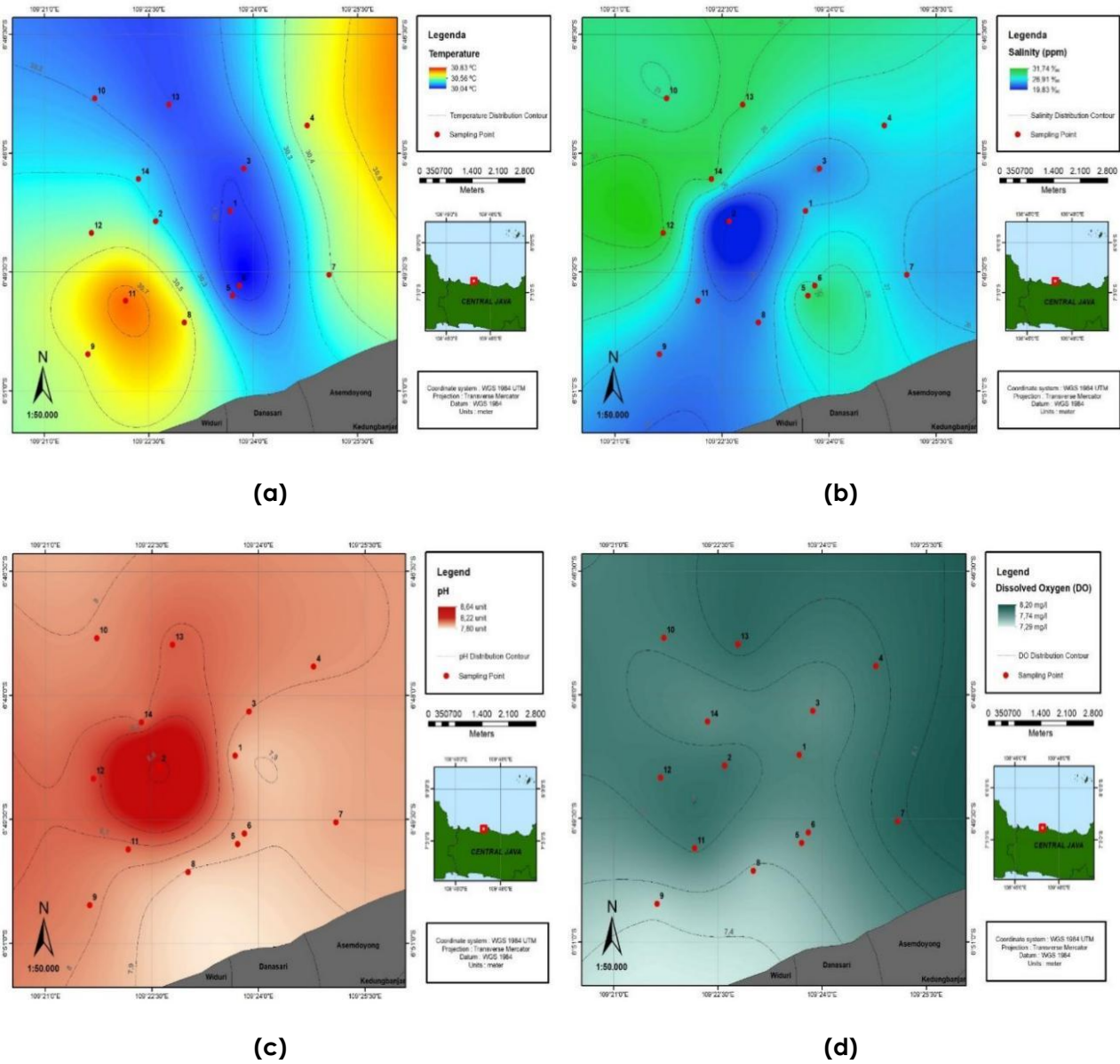


Figure 3. The oceanographic parameters, (a) water temperature, (b) salinity, (c) water pH, and (d) dissolved oxygen at the crab fishing location in Danasari waters

The water temperature obtained ranged from 30.0-30.8 °C, with an average water temperature of 30.31 ± 0.05 °C in this research areas. There is small difference temperature at each fishing location, caused due to the time data collection was carried out at the same time and there is no differences weather affected the water temperature. Based on the seawater quality standards for biota life in Government Regulation Number 22 of 2021, the water temperature at the fishing location is included in the appropriate category. The temperature of the waters in the high seas is generally minimal to influence or change, in contrast to areas around the coast which are still very highly affected due to input from river mouths (Sidabutar *et al.*, 2019). The results of observations of water temperature in this study were almost the same as locations in Cirebon waters (Firdaus *et al.*, 2020) with a temperature range of 28-29 °C, locations in Madura waters (Guntur *et al.*, 2017) with a temperature range of 27-32 °C, and locations in Senggarang waters (Mughni *et al.*, 2022) with a temperature range of 30-30.6 °C.

The water salinity ranged from 20-31 ppt, with an average salinity of 26.95 ± 0.6 ppt. The salinity levels of the waters obtained had significant differences at several fishing points, the lowest salinity value was found at point 4 with a salinity of only 20 ppt. Salinity in seawater with a low value is probably caused by influences from the land, such as mixing with fresh water carried by rivers (Nontji, 2002). Differences in seawater salinity can also be caused by mixing due to sea waves or the movement of water masses caused by wind (Banjarnahor, 2000). The salinity value in this study was not too much different from research in Cirebon waters (Firdaus *et al*, 2020) with a value of 25-30 ppt, in East Lampung coastal waters (Radifa *et al*, 2020) with 25 - 35 ppt, and in locations Jakarta Bay waters (Wagiyo *et al*, 2019) with 29.5-32 ppt. Other oceanographic parameters, namely the pH of the water obtained an average of 8.05 ± 0.04 and dissolved oxygen with an average of 7.86 ± 0.04 mg/L which are indicated to be suitable as a habitat for swimming crabs.

Sumiono *et al.* (2017) swimming crabs are biota that generally live in waters with temperatures between 17-35 °C. The life cycle of the blue swimming crabs already known by their pattern of migration or adapted to other places on several phases. Blue swimming crabs will migrate to waters with higher salinity to spawn their eggs (Jumaisa *et al.*, 2016). According to Potter and Lestang (2000), the temperature of the waters of the blue swimming crab habitat will affect metabolic processes directly related to growth, reproduction, spawning season, and gonadal maturation. In particular, the salinity of the waters affects the migration patterns of crabs, while the general water temperature of several crustaceans affects growth, especially after the molting process (Azra *et al.*, 2019). The result of water temperatures were lower and tend to be cold will inhibit the growth and maturation process of the crabs gonads.

Sex ratio and Growth Characteristic

The composition of the female and male crabs obtained unequal results, with a ratio value of 1.45:1. The number of male crabs found more in the fishing area than the number of female crabs at almost for every point of the fishing area. The growth of female and male crabs is negative allometric, provided from the b-value of the regression analysis method ($b < 3$). The results of the sex ratio analysis and the growth characteristics of the blue swimming crab are presented in Figures 4 and 5.

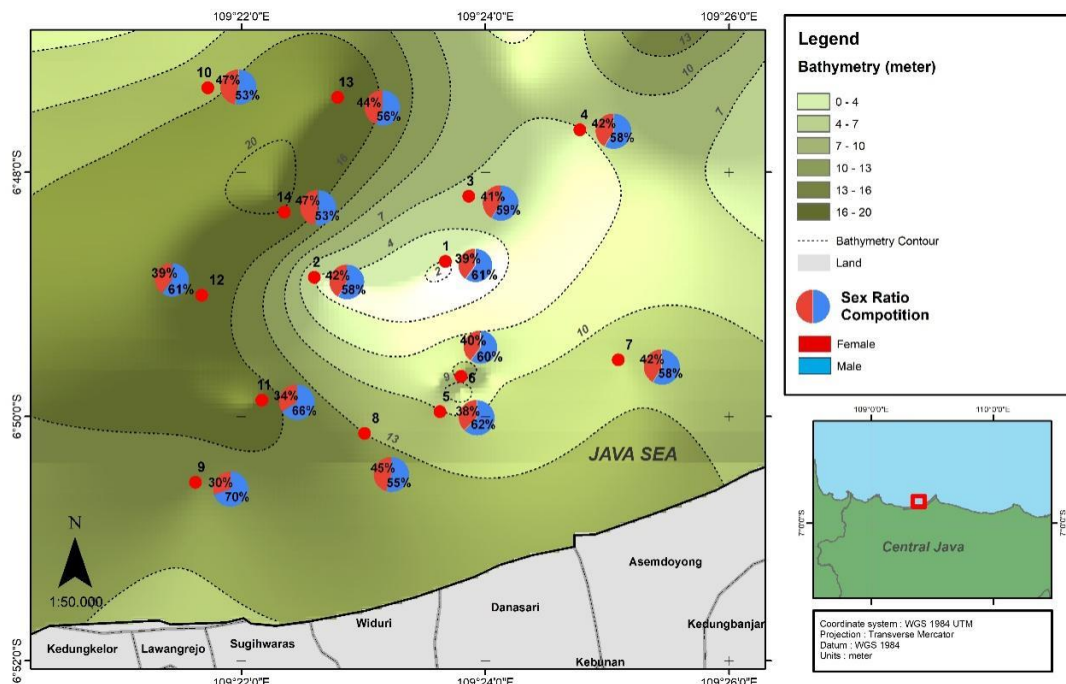


Figure 4. The composition distribution of female and male swimming crabs in the fishing area

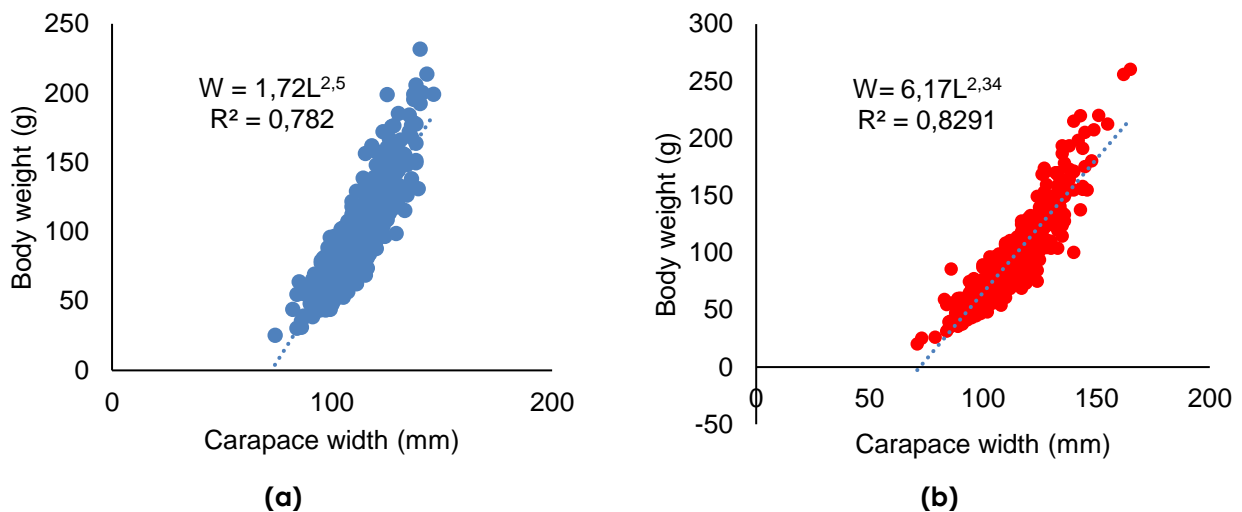


Figure 5. The analysis of Growth factors of male crabs (a) and female crabs (b) in the fishing area

The comparison of the composition of the number of female and male crabs in the waters of Danasari obtained where the number of male crabs are dominated in each fishing area. According to Sumpton *et al.* (1994), the composition of caught crab species is thought to be due to differences in behavior between female and male crabs, fishing activity, mortality rate, and natural recruitment. Female crabs are individuals who are more dominant in migrating, this is related to the spawning of crab eggs in deep waters with higher salinity (Hamid *et al.*, 2015). Information on the crab gender ratio is important to know, because the composition of female and male crabs in a population can describe the stability of crab resources in a water (Tharieq *et al.*, 2020). According to Josileen *et al.* (2011), rarely caught female crabs can be caused because during the process of gonad maturation and incubation of female crab eggs tend to rarely eat and even stop eating. The results of the sex ratio analysis in this study were not much different from research at the Senggarang Waters location (Mughni *et al.*, 2022) with a ratio of 1.4: 1.0 and at the Cirebon Waters location (Firdaus *et al.*, 2020) with a ratio of 1.6: 1.0, but different from the waters of Tanah Laut, South Kalimantan (Suman *et al.*, 2020) with a ratio of 1.0: 1.7 which caused due to differences in monsoon periods and water conditions.

The growth of female and male crabs in the fishing area of Danasari waters was found to be negatively allometric, which means that carapace width growth was faster than body weight growth ($b < 3$). According to Kamrani *et al.* (2010), crabs with positive allometric growth traits can be considered large and fat, while crabs with negative allometric growth properties have the same size but lighter body weight or can be considered skinny crabs. The different growth characteristics of blue swimming crabs from Danasari water to another, can be caused by environmental conditions such as currents, oceanographic conditions, and fishing pressure (Redjeki *et al.*, 2021). According to Shukor *et al.* (2008), the condition of water currents is related to the distribution and availability of food for fish, calm water currents make it easier to get food, conversely, fast water currents will make it more difficult for fish to find food. The results of the analysis of the growth characteristics of blue swimming crabs in this study were the same as those found in the waters of Jakarta Bay (Wagiyo *et al.*, 2019) and Tanah Laut waters, South Kalimantan (Suman *et al.*, 2020), while the growth characteristics were different from those in Cirebon waters (Firdaus *et al.*, 2020) which is most likely caused by the several differences in the factors mentioned above.

The size of carapace width in the fishing area obtained the largest carapace width of 168 mm, while the smallest carapace width was 71 mm with an average dominant carapace width found in the range of 92-112 mm. Egg berried female crabs were found in almost every point of the fishing area and almost similiar composition. The highest percentage of egg berried female crabs was found

at point 7 and point 13. The gonadal maturity level of the female crab is dominated by level 2, with a dome-like abdomen. The results of the analysis of crab distribution based on carapace width and the distribution of egg berried female crabs are presented in Figure 6.

According to Warner (1977), the composition of the size of the carapace width from one area to another caused several factors such as genetic factors and environmental factors. The analysis of size distribution of blue swimming crabs was used to describe and develop the condition of the blue swimming crab population in the sea waters (Redjeki *et al.*, 2021). Regulation of the Minister of Maritime Affairs and Fisheries Number 16 of 2022 states that the minimum size of crabs that may be caught is 100 mm, however, small crabs are still found in fishing areas caught by fishermen. Based on Figure 5, the size distribution of the width of the crab carapace at each fishing point was played in the 92-112 mm size class. These results are greater than those found in the waters of Jakarta Bay (Wagiyo *et al.*, 2019) with a carapace width class mode of 85 - 90 mm, but smaller than the results obtained in Kotabaru waters, South Kalimantan (Tirtadanu and Suman, 2017) with carapace width class mode of 110 - 120 mm, and in the waters of Bintan, Riau Islands (Muzammil *et al.*, 2021) with a carapace width class mode of 130 - 140 mm. Variations in crab size are thought to be caused by migration patterns and the crab life cycle. Hosseini *et al.* (2012), stated that young crabs are generally found in areas around the coast (coastline), while adults and larger crabs are found in deeper waters and higher salinity.

The female crabs were dominated at 2nd gonadal maturity level, with total 317 individuals from 376 individual female crabs. The distribution of female spawning crabs was almost occurring at each fishing area obtained in this study. Based on Figure 5, the highest proportion of female crabs conveying the eggs was at points 7 and 13. The presence of egg-laying female crabs is one of them influenced by the high salinity value, where the female crab will spawn her eggs (Sumpton *et al.*, 1994). The composition of the female swimming crab laying eggs at point 7 and point 13 has a difference in the width of the carapace, whereas the female swimming crab laying eggs at point 7 has an average carapace width smaller than that found at point 13. This condition thought to be due to differences in water depth, but also is an indication that there is an influence of pressure due

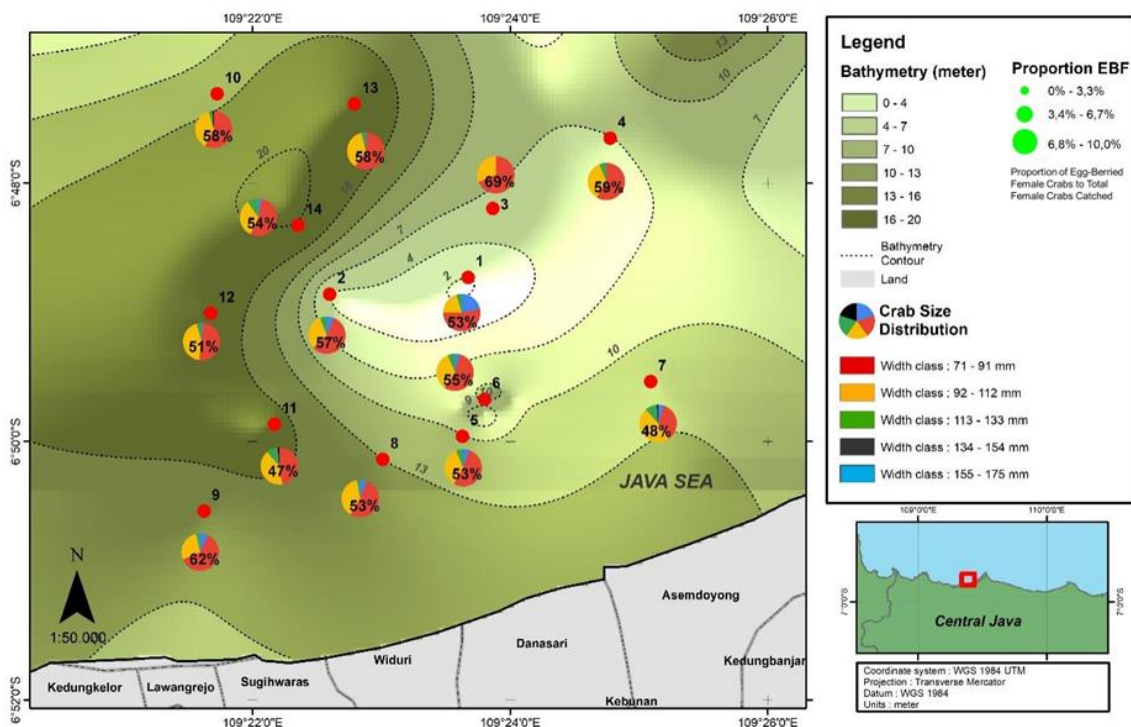


Figure 6. The sized distribution and percentage of Egg-Berried Female Crab in the Danasari waters

to fishing on blue swimming crab resources in the waters of Danasari and its surroundings. In accordance with the statement of Ernawati *et al.* (2015), pressure due to fishing can be seen in the finding of female swimming crabs that lay relatively small eggs, indicating that the female crabs are forced to mature gonads more quickly in order to maintain the population. With the following result from this research, scheduling rules for fishing activities can also be tested to be applied to provide opportunities for crabs to complete the reproductive cycle.

CONCLUSION

Oceanographic parameters in the Danasari area are suitable for blue swimming crab activities. A total of 14 fishing ground points obtained in this study resulted that male crabs are dominated. The growth of blue swimming crab from the fishing grounds in Danasari waters is negative allometric. The average carapace width found ranged from 92-112 mm, and female crabs were generally at gonadal maturity level 2. Female crabs laid eggs in almost every point of the fishing area, with different proportions. The highest ratio of female swimming crabs to laying eggs was obtained at points 7 and 13, but there were differences in the size composition of female swimming crabs laying eggs between the two points. The condition of the blue swimming crab in the waters of Danasari and its surroundings began to potentially overfished, this was evident from the discovery of relatively small egg berried female crabs. Efforts to complete a fishing activity need to be carried out smoothly to manage the availability of crab resources.

ACKNOWLEDGEMENT

The author would like to say thank you to Faculty of Fisheries and Marine Sciences, Diponegoro University for providing financial assistance in carrying out this research through the Assignment Letter for the Implementation of Research Grant Activities Number 251/UN7.5.10.2/PP/2022, and established the scientific publications. The authors also thank to all parties who have assisted in data collection and the process of preparing scientific publications.

REFERENCES

- Azra, M.N., Aaqillah-Amr, M.A., Ikhwanuddin, M., Ma, H., Waiho, H., Ostrensky, A., Tavares, C.P.S., & Abol-Munafi, A.B. (2019). Effects Of Climate-Induced Water Temperature Changes on The Life History of Brachyuran Crabs. *Review in Aquaculture*, 12380, 1–6. doi: 10.1111/raq.12380.
- Banjarnahor, J. (2000). Atlas Ekosistem Pesisir Tanah Grogot, Kalimantan Timur. Puslitbang Oseanologi - LIPI. Jakarta. 17 halaman
- Ernawati, T., Kembaren, D. & Wagiyono, K. (2015). Penentuan Status Stok Sumberdaya Rajungan (*Portunus pelagicus* Linnaeus, 1758) dengan Metode Spawning Potential Ratio di Perairan Sekitar Belitung. *Jurnal Penelitian Perikanan Indonesia*, 21 (2), 63-70. doi: 10.15578/jppi.21.2.2015.63-70.
- Firdaus, A.N., Baswantara, A. & Wibowo, Y.A. (2020). Biological and Environmental Parameters of Blue Swimming Crab Fisheries *Portunus pelagicus* in Cirebon. *Marine and Fisheries Science Technology Journal*, 1(2): 97-105. doi: 10.15578/marlin.V1.I2.2020.97-105
- Guntur G., Yanuar, A.T., Sari, S.H.J. & Kurniawan, A. (2017). Analisis kualitas perairan berdasarkan metode indeks pencemaran di Pesisir Timur Kota Surabaya. *Depik*, 6(1):81-89
- Hamid, A., Wardiatno, Y., Lumbanbatu, D.T.F., & Riani, E. (2015). Fecundity and Gonadal Maturity Levels of Female Crawfish (*Portunus pelagicus*) Incubating Eggs in Teluklasongko, Southeast Sulawesi. *Bawal*, 7(1), 43-50. doi: 10.15578/bawal.7.1.2015.43-50.
- Hosseini, M., Vazirizade, A., Parsa, Y., & Mansori, A. (2012). Sex Ratio, Size Distribution and Seasonal Abundance of Blue Swimming Crab, *Portunus pelagicus* (Linnaeus, 1758) in Persian Gulf Coasts, Iran. *World Applied Sciences Journal*, 17(7), 919-925.
- Huda, H.M., Wijaya, R. A., Triyanti, R., Sari, Y.D., & Zamroni, A. (2021). Status dan Permasalahan Pemanfaatan Sumber Daya Rajungan di Indonesia. *Jurnal Kebijakan Sosial Ekonomi Kelautan dan Perikanan*, 11(2), 119-126.
- Josileen, J. (2011). Morphometrics and Length-Weight Relationship in The Blue Swimmer Crab, *Portunus pelagicus* (Linnaeus, 1758) (Decapoda, Branchyura) from the Mandapam Coast, India. *Crustaceana*. 84(14), 1665 – 1681. doi: 10.1163/156854011X607060.

- Jumaisa, Idris, M. & Astuti, O. (2016). Effects of Different Salinity Levels on the Growth and Survival Rate of Juvenile Swimming Crab (*Portunus pelagicus*). *Media Akuatika*, 1(2), 94-103.
- Kamrani, E., Sabili, A.N. & Yahyavi, M. (2010). Stock Assessment and Reproductive Biology of the Blue Swimming Crab, *Portunus pelagicus* in Bandar Abbas Coastal Waters, Northern Persian Gulf. *Journal of the Persian Gulf*, 1(2), 11-22.
- Kohinoor, S.S., Azizarshad, S.N., & Kamarudin, M.S. & Sulaiman, M.A. (2019). Evaluation of Water Quality Parameters, Growth and Proximate Composition of Juvenile Crab, *Portunus pelagicus* Cultured in RAS and Non RAS System. *Sains Malaysiana*, 48(10), 2143–2149. doi: 10.17576/jsm-2019-4810-09
- Kumar, M.S., Xiao, Y., Venema, S., & Hooper, V. (2003). Reproductive cycle of the blue swimmer crab, *Portunus pelagicus*, off Southern Australia. *Journal of The Marine Biology Association of The U.K.*, 83(05), 983-994. doi: 10.1017/S0025315403008191h.
- Kunsook, C., Nantana, G., & Nittharatana, P. 2014. A Stock Assessment of The Blue Swimming Crab *Portunus pelagicus* (Linnaeus, 1758) for Sustainable Management in Kung Krabaen Bay, Gulf of Thailand. *Tropical Life Sciences Research*, 25(1), 41–59.
- La Sara., Halili., Mustafa A., & Bahtiar. (2016). Appropriate escape vent sizes on collapsible crab pot for blue swimming crab (*Portunus pelagicus*) fishery in southeast Sulawesi waters, Indonesia. *Journal of Fisheries and Aquatic Sciences*, 11(6), 402-410. doi: 10.3923/jfas.2016.
- Mughni, F.M., Susiana & Muzammil, W. (2022). Biomorfometrik Rajungan (*Portunus pelagicus*) di Perairan Senggarang. *Journal of Marine Research*, 11(2), 114-127. doi: 10.14710/jmr.v11i2.33085
- Muzammil, W., Apriadi, T., Melani, W.R., & Damora, A. (2021). Bioinformation of Blue Swimming Crab (*Portunus pelagicus*) during Covid-19 Pandemic in Bintan District, Riau Islands Province. *Journal of Tropical Fisheries Management*, 5(2), 65 - 72.
- Nontji, A. 2002. Laut Nusantara. Penerbit Djambatan. Jakarta: 59-67.
- Phillips, H.A., Redjeki, S., & Sabdono, A. (2022). Morfometry Analysis of Rajungan (*Portunus pelagicus*) In Keboromo Village, Pati Regency, Central Java. *Journal of Marine Research*, 11(3), 429-436. doi: 10.14710/jmr.v11i3.33340.
- Potter, I.C., & Lestang, D.S. (2000). The biology of the blue swimmer crab *Portunus pelagicus* in the Leschenault Estuary and Koombana Bay in south-western Australia. *Journal of the Royal Society of Western Australia*, 83(264), 443-458.
- Prihatiningsih., & Wagiyono, K. 2009. Sumber Daya Rajungan (*Portunus pelagicus*) Di Perairan Tangerang. *Bawal*, 2(6), 273-282. doi: 10.15578/bawal.2.6.2009.273-282.
- Radifa, M., Wardiatno, Y., Simanjuntak, C.P.H., & Zairion, Z. (2020). Habitat preference and spatial distribution of juvenile blue swimming crab (*Portunus pelagicus*) in the East Lampung coastal waters, Lampung Province. *Journal of Natural Resources and Environmental Management*, 10(2), 183-197. doi: 10.29244/jpsl.10.2.183-197.
- Redjeki, S., Zainuri., M., Widowati, I., Ambariyanto, Pribadi, R. & Abbey, M. (2021). Sex Ratio, Size Distribution and Length-Weight Relationship of *Portunus pelagicus* Linnaeus, 1758 (Malacostraca: Portunidae) in Betahwalang, Demak, Central Java. *Jurnal Kelautan Tropis*, 24(1), 133-140.
- Sari, M.P., Bambang, A.N., & Sardiyatmo. (2016). Analisis Distribusi Pemasaran Rajungan (*Portunus pelagicus*) di Desa Sukoharjo, Kabupaten Rembang, Jawa Tengah. *Journal of Fisheries Resources Utilization Management and Technology*, 5(1), 128-133
- Shukor, M.Y., Samat A., Ahmad A.K., & Ruziaton J. (2008). Comparative analysis of length-weight relationship of *Rasbora sumatrana* in relation to the physicochemical characteristic in different geographical areas in peninsular Malaysia. *Malaysian Applied Biology*, 37(1), 21-29.
- Sidabutar, E.A., Sartimbul, A. & Handayani, M. (2019). Distribusi Suhu, Salinitas dan Oksigen Terlarut Terhadap Kedalaman Di Perairan Teluk Prigi Kabupaten Trenggalek. *Journal of Fisheries and Marine Research*, 3(1), 46-52.
- Suman, A., Hasanah, A., Pane, A.R.P. & Lestari, P. (2020). Stock Status of Blue Swimming Crab (*Portunus pelagicus*) In Tanah Laut, South Kalimantan, And Its Adjacent Waters. *Indonesian Fisheries Research Journal*, 26(1), 51 - 60. doi: 10.15578/ifrj.26.1.2020.51-60
- Sumiono, B., Ernawati, T., & Maduppa, H. (2017). Reproductive Ecology, Spawning Potential, and Breeding Season of Blue Swimming Crab (Portunidae: *Portunus pelagicus*) in Java Sea, Indonesia. *Biodiversitas Journal of Biological Diversity*, 18(4), 1705-1713. doi: 10.13057/biodiv/d180450.

- Sumpton, W.D., Potter, M.A., & Smith, G.S. (1994). Reproduction and Growth of the Commercial San Crab, *Portunus pelagicus* (L.) in Moreton Bay, Queensland. *Asian Fisheries Science*, 7(2-3), 103-113. doi: 10.33997/j.afs.1994.7.2-3.004
- Tharieq, M.A., Sunaryo., & Santoso, A. (2020). Morphometric and Gonad Maturity Level of Blue Swimming Crab (*Portunus pelagicus*) Linnaeus, 1758 (Malacostraca: Portunidae) in Betahwalang Waters, Demak. *Journal of Marine Research*. 9(1), 25-34. doi: 10.14710/jmr.v9i1.26081.
- Tirtadanu & Suman, A. (2017). Biological Aspect, Population Dynamics and Exploitation Rate Of Blue Swimming Crab (*Portunus Pelagicus* Linnaeus, 1758) In Kotabaru Waters, Kalimantan Selatan. *Jurnal Penelitian Perikanan Indonesia*, 23(3), 205-214.
- Wagiyo, K., Tirtadanu & Ernawati, T. (2019). Fishery and Population Dynamics of Blue Swimmer Crabs (*Portunus pelagicus* Linnaeus, 1758) in Jakarta Bay. *Jurnal Penelitian Perikanan Indonesia*, 25(2), 79-92. doi: 10.15578/jppi.25.2.2019.79-92
- Warner, G.F. (1977). *The Biology of Crabs*. Paul Elek Scientific Books, London.